

How does part orientation affect a 3D Print?

Written by [Ben Redwood](#)

This article discusses the impact part orientation has on the accuracy, strength, speed and surface finish of 3D printed parts.

Table of contents

Introduction
Importance of part orientation
Part orientation by technology

Introduction

Designers often overlook the importance that part orientation plays in the final quality of a 3D print. This article discusses how print orientation impacts additive manufacturing processes and also addresses the importance of build orientation by technology.

Importance of part orientation

Part accuracy

Consider a cylinder that is built with a vertical center axis. Additive manufacturing techniques would construct this part as a series of concentric circles layered on top of one another. This would produce a final cylinder with a relatively smooth outer surface. If the same cylinder is reorientated with a horizontal center axis the final product would now have a layer stepping finish on the surface and may require support to complete the print successfully. The cylinder will also now have a flat surface down one side where the initial first layers were printed. By reorienting there is a significant difference in the quality of the final part as shown below.



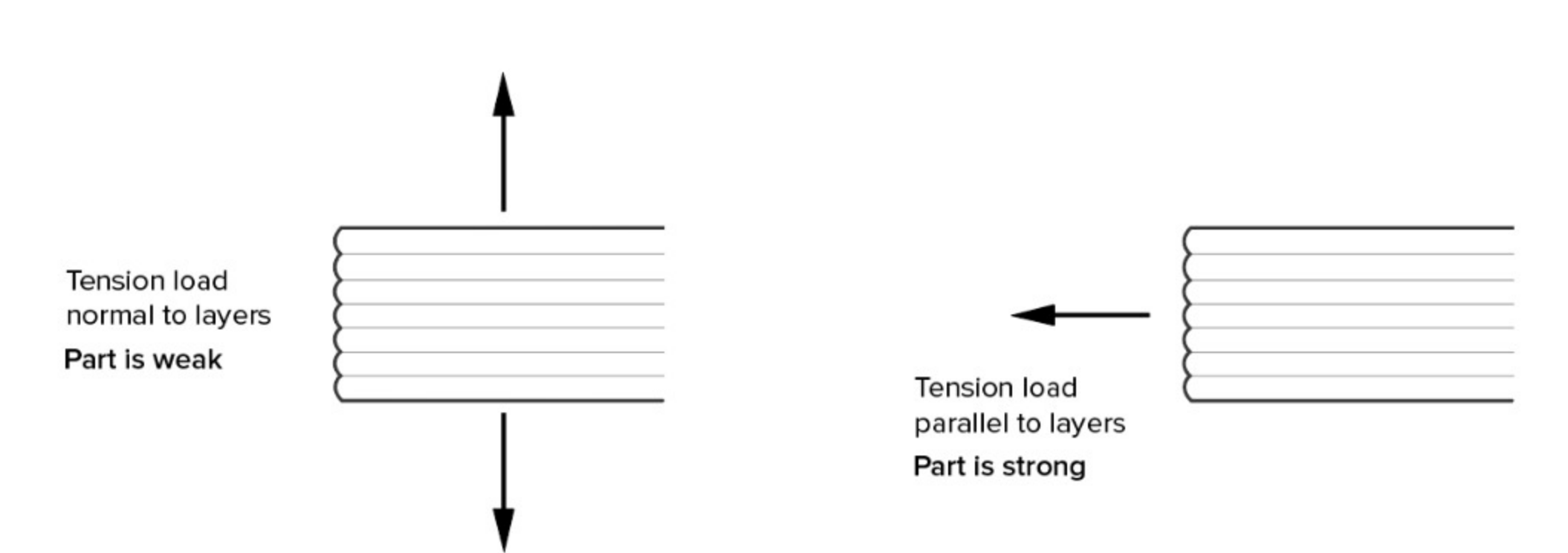
2 Identical cylinders with equal layer height printer In different orienations (Left - vertical axis and right - horizontal axis)

Time to print

Orientation can also have an impact on print time. Using the cylinder example from above, for most 3D printing technologies the horizontal axis orientation will take significantly less time to print when compared to the vertical as the total number of printed layers is reduced. For material extrusion processes such as FDM this is not a governing factor as the volume of the build is the same.

Part strength

Some additive manufacturing methods (most importantly FDM) are very anisotropic meaning they have different properties in the x and y directions when compared to the z (or build) direction. It is important to consider the application of a part and the direction loads will be applied if the part is functional. FDM parts are much more likely to delaminate and fracture when placed in tension in the z direction compared to the x and y as the image below illustrates.



3D printing technologies generally are much stronger In one direction compared to another

Support

Many designers overlook the fact that printing support material adds extra time and cost to a build. Often a lot of time is spent determining the optimal part orientation to reduce the likelihood of print failure and the amount of support that is being used. More information on how to optimise the use of support in a design can be found [here](#).

Surface finish

In general the top or upward facing surface of a 3D print will have the best surface finish.

- For FDM the top surface is not in contact with the build plate and it typically smoothed by the extrusion tip.
- For SLA the top surface does not have any support in contact it meaning it requires no post processing.
- Powder based printing methods like SLS and binder jetting allow the top surface to be solidified by air while the bottom and side surfaces solidify against powder and therefore have a powdery texture.

Part orientation by technology

The following table outlines how important part orientation is on the quality of a part based on the printing technology. This is irrespective of optimising support material or build plate space.

Technology	Importance of part orientation
FDM	Very important
SLA	Very important
SLS	Not important
Polyjet	Important
Binderjet	Not important
Metal printing (SLM or DLSM)	Very important

Importance of part orientation on print quality

Written by



Ben Redwood
Mechanical engineer working at 3D Hubs